Sitzungsberichte der Naturwissenschaftlichen Gesellschaft Isis, Dresden, 1884.—Osteology of *Rana temporaria*, L., and *Rana esculenta*, L., by H. Reibisch.—Note on *Testudinaria elephantipes*, Lindl., and *Welwitschia mirabilis*, Hook, by Prof. O. Drude.—Biographical notices of the late Dr. H. R. Göppert of Breslau, of F. von Hochstetter of Vienna, and of Dr. W. Gonnermann of Coburg, by Dr. Geinitz.—Mineralogical and geological results of a journey to Italy in the year 1884, by A. Purgold.—On a prehistoric necropolis at Trög, near Rosegg, Carinthia, by W. Osborne.—On some metal objects recently discovered at Jessen, near Lommatsch, by Dr. Caro.—On the increase of accidents from lightning in the Kingdom of Saxony, by Johannes Freyberg.—Remarks on some urns and other archæological remains lately discovered at Uebigau, near Dresden, by Dr. J. von Deichmüller.—Memoirs on the phanerogamous flora of the Voigtland district, Saxony, by A. Artzt.—On the granites, gneiss, crystallised limestones, schists, and other primitive rocks occurring in the districts north of the Zittau and Jeschken ranges, by Emil Danzig.

Rendiconti del Reale Istituto Lombardo, May 7.—Results so far obtained from the study of the chief ichthiofauna of the Cretaceous period, by Prof. F. Bassani. This elaborate monograph concludes with a comparative table of the fossil fishes of Pietrarvia, Voirons, Comen, Lesina, Crespano, Monte S. Agata, Grodischtz, Tolfa, and Hakel.—A contribution to the study of etherification by double decomposition: formation of the nitrous ether of allylic alcohol, by Prof. Giacomo Bertoni. —Further remarks on the functions which satisfy the differential equation $\Delta^2 u = 0$, by Prof. Giulio Ascoli.—Remarks on the modifications introduced by the present Minister, Pessina, into the Penal Code proposed by Savelli, by E. A. Buccellati.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 18.—"Regional Metamorphism," by Joseph Prestwich, M.A., F.R.S., Professor of Geology in the University of Oxford.

Metamorphic rocks have been divided into two classes—(1) Those in which the change has been caused by contact with heated eruptive rocks; (2) Those extending over wider areas, in which the rocks are in no apparent relation to eruptive or igneous rocks. The first has been termed *Contact Metamorphism*, and the second *Normal* or *Regional Metamorphism*, the latter two terms having been used to express the same phenomena and treated as synonymous.

The author, however, for reasons to be assigned, proposes, while retaining the use of both the latter terms, to apply them differently. Normal metamorphism he would confine, as hitherto, to the changes caused by the heat due to depth, on the supposition of the existence of a heated central nucleus of the earth, while he would use the term *regional metamorphism* to denote changes effected by the agency of the physical causes to which Mr. Mallet referred the fusion of the volcanic rocks, namely, *the heat produced locally within the crust of the earth by transformation into heat of the mechanical work of compression, or of crushing of portions of that crust.*

The primary object of Mr. Mallet's experiments was to ascertain the force required to crush portions of various rocks of given size, and to determine the quantity of heat evolved by the process. For this purpose the work done was measured by the number of cubic feet of water at 32° F. that could be converted into steam of one atmosphere (or at 212° F.) by the estimated heat evolved by the crushing of 1 cubic foot of each class of rock.

With all the harder rocks the heat produced in the metal surroundings by the complete crushing was easily perceptible by the hand, and was so great with some of the granites and porphyries as to necessitate a delay for the apparatus to cool. Both Mr. Mallet and Prof. Rankine were of opinion that in the crushing of a rigid material such as rock *almost the entire* mechanical work (with the exception of a small residue of external work) reappears as heat. It was further shown that, even in the most rigid bodies, crushing begins by compression and yielding, and that at this stage heat begins to be evolved.

Consequently the work thus developed being transformed into heat, that heat will be greatest along those lines or planes at places where the movement and pressure, together constituting the work, is greatest; whence Mallet concluded that along or about such axial lines of concentrated compressive and crushing work the temperature may locally rise to a red heat, or even to that of fusing the rocky materials crushed and of the pressing-together-walls themselver adjacent to them. This was in his opinion the real nature and origin of the volcanic heat as now produced on the globe.

Although the hypothesis fails for various reasons in its application to vulcanicity, especially for the reason that the great lines of disturbances and compression of the Alps, Pyrenees, and other mountain chains are free from either active or extinct volcanoes, there is, nevertheless, reason to believe that this source of heat may have been adequate to produce great molecular changes in the rocks along the lines of disturbance and upheaval, though the extreme results obtained by entire crushing by mallet would rarely or ever occur in nature. It is, however, precisely along such lines that not only are older rocks metamorphosed, but rocks of Cretaceous and Tertiary age—which usually have not been affected by normal metamorphism—coming, in these mountain-chains, under the influence of the disturbing forces, have undergone a change analogous to that produced by normal metamorphism.

Objections have been raised to the explanation offered in some cases of alteration of sedimentary strata in mountain-chains by ordinary normal metamorphism, on the grounds that unaltered strata alternate with altered strata. Sometimes this may be explained by inversion of the strata, or, where that is not the case, it may be due to the circumstance that differences of mineral composition, or in the proportion of the water of imbibition, have caused the metamorphism to affect different beds in different degrees. On the theory of *regional metamorphism*, in the sense the author would use it, another explanation suggests itself by the way in which differences in the resistance of the rocks develop different quantities of heat. Mr. Mallet has shown by experiments on the compressibility of rocks at Holyhead that, although certain slate-rocks were compressed by precisely the same force before their elastic limits were passed, yet, owing to differences in their compressibility, the heat developed in the rocks when released would render the quartz-rock nearly three times as hot as the slate-rock. In this manner, therefore, it seems possible to account for a special and restricted metamorphism of the strata in mountain-chains, and for its frequently localised occurrence.

The remarkable changes which take place in the condition of the coal of Pennsylvania, as it ranges into the Appalachian Mountains, may also be owing more probably to *regional* than to normal metamorphism. This mountain-range consists of a series of great parallel folds increasing in acuteness as the central axis is approached. Eruptive rocks are absent, but, nevertheless, the strata as they approach the central chain become more crystalline, and the coal, which at a distance is ordinary bituminous coal, passes into anthracite and even graphite. The late Prof. H. D. Rogers divided this great coal-field into four basins. The coal in the less-disturbed district near the Ohio River, where the flexures are extremely gentle and wide apart, contains from 40 to 50 per cent. of volatile matter; from the wide basin further east it decreases to 30 or 35 per cent.; in the basins of the Alleghany range, in which, although there are no important dislocations or great flexures, there are some extensive and symmetrical anticlinal axes of the flatter form, the proportion of the volatile matter in the coal varies from 16 to 22 per cent.; while in the most easterly chain of basins which are associated with the boldest flexures and greatest dislocations, with close plications and inversions of strata, the quantity of volatile matter in the coal is reduced to 6 to 14 per cent.

A somewhat analogous instance is presented by the Carboniferous series of Belgium. The excessive squeezing, faulting, and inversion which the Coal-measures have undergone on the flanks of the axis of the Ardennes, is there accompanied by an alteration of the highly bituminous coals into dry coals and into anthracite; while the Carboniferous and Devonian limestones amidst the sharply convoluted and folded strata of the Ardennes are there, as they are also on the line of the same disturbance in the Boulonnais, transformed very generally into crystalline marbles. The few exposures of eruptive rocks are all on a small scale, and affect the adjacent rocks only by contact metamorphism. It is probable that the anthracite of South Wales is the result of similar *regional metamorphism*.

In the case of contact metamorphism the changes were produced by great heat, for the eruptive rocks must have had a temperature of 3000° to 4000° F. or more; while in the case of normal metamorphism it is evident that the changes produced did not depend so much on high temperature as on pressure or the presence of water, and there is reason to believe that a temperature of about 600° to 800° F. would suffice to produce all or almost all the observed hydrothermal effects. For although in many instances of normal metamorphism new minerals are formed, the rocks are not fused, nor are the fossils destroyed. In Brittany, black slates which pass into schists with large crystals of chiastolite still show impressions of *orthis*, *trilobites*, and other Silurian fossils. Devonian strata in the Vosges pass into a rock consisting of pyroxene, garnet, epidote, &c., and yet retain impressions of *corals*.

Of the enormous tangential pressure exercised in the elevation of these chains, some idea may be formed when we consider the amount of compression which those portions of the crust have undergone. Thus, for example, Heim estimates that in the Alps the compression has been to the extent of 72 miles; and in a recent paper by Prof. Claypole he arrives at the conclusion, after a careful investigation of the magnitude and width of each fold, that in the Appalachian Mountains "a tract of the earth's surface, measuring originally 153 miles from south-east to north-west, has been so crushed and compressed that its present breadth along the line of section is only 65 miles," and of this, in one part—the Cumberland Valley—"95 miles of country have been compressed into 16 miles."

These vast compressions could not have taken place without the transformation into heat of the equivalent amount of mechanical work, though the degree and centralisation of the heat would depend on the rapidity and completeness with which the crushing has been effected. It is not therefore surprising to find that, in some of the newer mountain-ranges, a small residual portion of the heat thus mechanically evolved may still exist and cause slight aberrations in the position of the underground isothermal lines, and the same cause may possibly account for other exceptional cases.

The only sufficiently complete set of observations on a mountain-chain of this character that have yet been made are those before alluded to by Dr. Stapff in the St. Gothard Tunnel. The author has before given, in his paper on "Underground Temperatures," particulars of these observations, and therefore here only mentions that at the north end of the tunnel in the part where an axis of elevation of late geological age (Pliocene) traverses the range, the thermic gradient, which normally equals about 57 feet for 1° F., is there not more than 38 feet; and for this Dr. Stapff states that there was no obvious explanation.

The author concludes by expressing a belief that there exists, in the compression and motion of the strata which has always accompanied the upheaval of mountain-chains, a *vera causa* for the production of an amount of heat sufficient to produce one form of metamorphic action—a form which can affect only particular regions—and he would, therefore, in order to show its distinctiveness from either *contact* or *normal* metamorphism, designate it by the term of "*Regional Metamorphism.*"

Physical Society, June 13.—Prof. Guthrie, President, in the chair.—On the winding of voltmeters, by Profs. W. E. Ayrton and John Perry. As it is most important that voltmeters, ohmmeters, powermeters, and ergmeters should be so constructed that the percentage increase of resistance of their fine wire coils due to the heating effects of the currents passing through them should be as small as possible, the question arises as to whether such coils should be made of German silver wire, or of copper, or partly of German silver and partly of copper wire, and how the diameter of the wire should vary in different parts of the coil. The authors have therefore been led to investigate the conditions that make this heating error a minimum with cylindrical coils of internal and external radii r_0 and r_1. At a place whose distance from the axis is r, let the cross-section of the wire be x_1, ρ the specific resistance of the material; then, assuming that $x = x_0 r^a$, $\rho = \rho_0 r^b$, $\rho r = \rho_0 r_0 r^c$, and that a current, C, in one spire of radius r produces a magnetic effect, KCr^d, on the supended needle, they find that the heating error is proportional to

$$r_0 \rho_0 \frac{p^2}{(r_1^p - r_0^p)^2} \cdot \frac{n}{r_1^n - r_0^n} \cdot \frac{r_1^m - r_0^m}{m},$$

where $p = d - a + 1$, $n = 2 + b - 2a$, $m = 2 + 1{\cdot}7144b - 4a$. The conditions that make this expression a minimum are worked out in the paper, the result being that with one of their magnifying spring solenoid instruments, where $d = -1$, the values of a and b giving a minimum value are $a = 0{\cdot}325$ and $b = -0{\cdot}5$, and since in practice b cannot be negative, they conclude that $b = 0$ and $a = {\cdot}4$ give the best results—*i.e.*, that all the wire employed in the bobbin should be of copper, and the law of increase of cross-section proceeding from the centre should be $x = x_0 r^{0{\cdot}4}$. The actual waste of energy in the instruments is next considered, and, lastly, the authors show how to pass from a voltmeter with known winding, and whose maximum reading is P_1 to another of the same volume and shape whose maximum reading is to be P_2, and they conclude that, as they have shown that the waste of energy is the same in both for their maximum readings, the resistances of the instruments must be proportional to the squares of P_1 and P_2, or, following the law already arrived at for a minimum error due to heating, the cross-sections of the wires of the two instruments at similar places must be inversely proportional to P_1 and P_2. The employment of outside coils for voltmeters is considered, and it is shown that if we desire the same error in the two instruments due to heating when the outside resistance coils are of the same size and shape, it is necessary to have the same ratio between the resistance of the resistance coil and that of the magnetising coil in the two cases. To have a less or a greater error in the second case it is only necessary to use the equation—

$$e\,(\text{the error}) = \frac{2 + F.V}{1 + F.V},$$

where F is a constant and V the volume of the German silver resistance coil. From this V may be determined and the ratio $\frac{R_1}{R}$ of the resistances of the resistance coil and the magnetising coil is given by $\frac{R_1}{R} = \frac{F}{D} V$, where D is a constant which, like F, is obtained from experiments on the first instrument. The diminution of the heating error by using much iron in the instrument so as to obtain the same magnetic action with a much smaller current is discussed, and experiments were shown to illustrate how such employment of iron introduced a permanent magnetism error and caused the indications of such an instrument on the lower part of the scale to be uncertain and to depend upon whether measurements were being made with an increasing or a diminishing current.—On the manner in which light affects the resistance of selenium and sulphur cells, by Mr. Shelford Bidwell. In a communication made to the Society at its last meeting, the author had described a sulphur cell which behaved in all respects like a selenium cell when exposed to light. The action of this cell was supposed to be electrolytic, the sulphur containing a small quantity of sulphide of silver. If this were the case the result of a current traversing the cell would be to deposit sulphur upon the anode, and, as sulphur has an enormous resistance, that of the cell would increase unless the sulphur thus deposited combined with the silver. It is this combination that is believed to be much facilitated by light, a supposition the author believed he had confirmed by direct experiment. Mr. Bidwell had also measured the resistance of a piece of selenium that was believed never to have been heated in contact with a metal. The specimen was crystallised by heating for some time in a glass mould, two opposite sides cleaned, and two pieces of tinfoil between which the resistance was measured pressed against them. In this way the specific resistance was found to be 2500 megohms, which is enormously higher than that of the selenium in the "cell," a fact tending to confirm the theory that the conduction in such cells is due to the electrolysis of the selenides of the metals forming the terminal produced in the "cooking," and similar to that of the sulphur cell described above.—On the error involved in Prof. Quinke's method of calculating surface tensions from the dimensions of flat drops and bubbles, by Mr. A. M. Worthington. In a series of well-known papers Prof. Quinke has recorded a large number of measures of flat drops and bubbles, from which he has deduced the values of tensions for the free surface of a liquid and for the common surface of two liquids in contact. The numerical results obtained in this way exceed those obtained from observations upon the rise in capillary tubes, which Prof. Quinke attributes chiefly to the fact that in the latter case the edge angle is not zero. Mr. Worthington, however, shows that the surface tensions obtained by Prof. Quinke with flat drops are too high, this arising from his having assumed that the drops were flat at the vertex. The error thus introduced is very considerable, amounting in most cases to as much as 10 per cent. of the whole value, and upon its being duly corrected, the values obtained do not appreciably exceed those obtained with capillary tubes.—On a comparison between the mercury standards of resistance issued by M. Mascart with those of the British Association, by Mr. R. T. Glazebrook.

Anthropological Institute, June 23.—Francis Galton, F.R.S., President, in the chair.—The election of the following new members was announced.—Prince Roland Bonaparte, Lady Brassey, Miss M. North, Dr. Robert Brown, M.A., Col. Cadell, V.C., C. Heape, H. H. Johnston, D. MacRitchie, Prof. H. N. Moseley, F.R.S., C. Seidler.—Lady Brassey exhibited a collection of objects of ethnological interest from Polynesia.—Several ethnological specimens from New Ireland were exhibited by Miss North.—Mr. Carl Lumholtz exhibited a series of Australian implements.—Mr. H. B. Guppy read a paper on the physical characteristics of the natives of the Solomon Islands. In this paper the author gave the results of observations made during the years 1881–84 on the natives of certain localities in the Solomon group. The typical Solomon Island native (male) is well proportioned, with a height of about 5 feet 3 inches, a weight of 125 to 130 lbs., and a chest-girth between 34 and 35 inches, whilst the colour of his skin is a deep brown, corresponding with colour-type 35 of M. Broca. Considerable variety, however, prevails in the physical characters of these natives, and it was shown, by comparing the inhabitants of the islands of Bougainville Strait with those of St. Christoval and its adjoining islands at the opposite end of the group, that in the former locality there exists a taller, darker, and more brachycephalic race, whilst in the latter mesocephaly prevails, and the average native is rather shorter and of a lighter hue. The colour of the skin varies considerably throughout the group from a very deep brown to a light copperish hue, the range being represented by colour-types 42 and 29 with their intermediate shades. After making 109 measurements of the heads and skulls of natives in order to obtain the ratio of the transverse to the longitudinal diameter, the author arrived at the conclusion that, although mesocephaly and brachycephaly most frequently characterise these people, the form of the skull varies between too wide limits to allow of one particular type being referred to this group. The range of the cephalic indices calculated from these measurements is 69 to 86, and the greater number are gathered in two groups—one around the indices 74 and 75, and the other around the indices 79 and 80.—The following papers were also read:—On the Sakais, by Mr. Abraham Hale.—Notes on the astronomical customs and religious ideas of the Chokitapia or Blackfeet Indians, by M. Jean L'Heureux.—Observations on the Mexican zodiac and astrology, by Mr. Hyde Clarke.—On the primary divisions and geographical distribution of mankind, by Mr. James Dallas.

Entomological Society, June 3.—R. McLachlan, F.R.S., President, in the chair.—Two new members were elected.—Exhibitions: Mr. F. P. Pascoe, aërial roots of an orchid which resemble caterpillars; and a new genus and species of *Colydiidæ* from North Borneo.—Mr. G. T. Porritt, larvæ of *Phycis betulæ* and of *Coleophora currucipennella*.—Mr. R. McLachlan, a specimen of *Deiopeia pulchella* captured on board ship in the Atlantic, many miles from land.—Mr. J. W. Douglas communicated notes on an apple-tree destroyed by *Schizoneura lanigera* and *Mytilaspis pomorum*, and Mr. F. Enock read the completion of his account of the life-history of *Atypus piceus*.

PARIS

Academy of Sciences, June 22.—M. Bouley, President, in the chair.—At the opening of the proceedings the President announced the death of M. Tresca, member of the Section for Mechanics, who died on June 21, and in whom the Academy loses one of its most distinguished and active associates.—Note on Dr. Raphael Dubois' apparatus for applying anæsthetics composed of titrate mixtures of chloroform and air, by M. Paul Bert. This apparatus has been tried with the greatest success in Brussels and Ghent, and especially by Dr. Péan of Paris, who has already tested its efficiency in 400 surgical operations. The anæsthesia in nearly all cases continues perfectly regular and complete, without any interruption, even under severe operations. The pulse remains normal, the respiration easy and undisturbed, the awakening calm and natural.—On the superiority of the new "tubes à ailerons" over the ordinary smooth cylinders at present employed in tubular boilers for generating steam, by M. J. Serve. The author and inventor claims by these cylinders to have solved the problem how to produce the greatest quantity of heat with the least expenditure of fuel.—On an arrangement by which the magnetic potential due to a system of bobbins may be determined without calculation, by M. G. Lippmann.—Note on the influence of thunderstorms on underground telegraphic wires, by M. Blavier. The occasional disturbances, to which even well-protected underground wires are subject, apparently in opposition to the theory of static electricity, the author thinks may be explained either as an effect of electrodynamic induction, or as an effect of electrostatic induction.—On the molecular lowerings which constitute the limits of congelation for bodies dissolved in water, by M. F. M. Raoult.—Description of two new types of hygrometers, by M. Bourbouze.—On the transformation of sulphur: MM. Reicher and Ruys' claims of priority of invention in connection with M. Gernez's recent communications, by M. J. H. Van't Hoff.—Alkaloids produced by the action of ammoniac on glucose, by M. C. Tauret.—Action of the seleniates and selenites, and the alkaloids. A new reaction of codeine, by M. Ph. Lafon.—Note on Aseptol (orthoxyphenylsulphurous acid), by M. E. Terrant.—Contribution to the study of antiseptics. Action of antiseptics on the higher organisms. Thymic acid, by MM. A. Mairet, Pilatte, and Combemale.—On the process of fructification of the genus Callipteris, by M. Ed. Bureau.—On the infusoria by Balbiani named *Anoplophyra circulans*, by M. A. Schneider.

CHRISTIANIA

Society of Science, May 15.—Herr Worw-Müller referred to the meritorious work of the recently-deceased Danish Prof. Panum, as regards physiology as well as pathology. He further presented a paper in which he demonstrated the utility of Robert's method for the determination of sugar in animal substances when above 0·4 per cent. Finally he explained the researches made by Herr J. Otto on the functions of the sugar in the liver. He stated that they proved that the blood contained far more sugar on entering than on leaving the liver, and more than the blood in general. The researches went to support M. Bernard's experiences, viz., that the quantity of sugar formed in the liver in the course of twenty-four hours was much larger than hitherto thought.—Prof. O. Sars presented a paper: "A contribution to the Norwegian invertebrate fauna," by Herr C. A. Hansson.

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